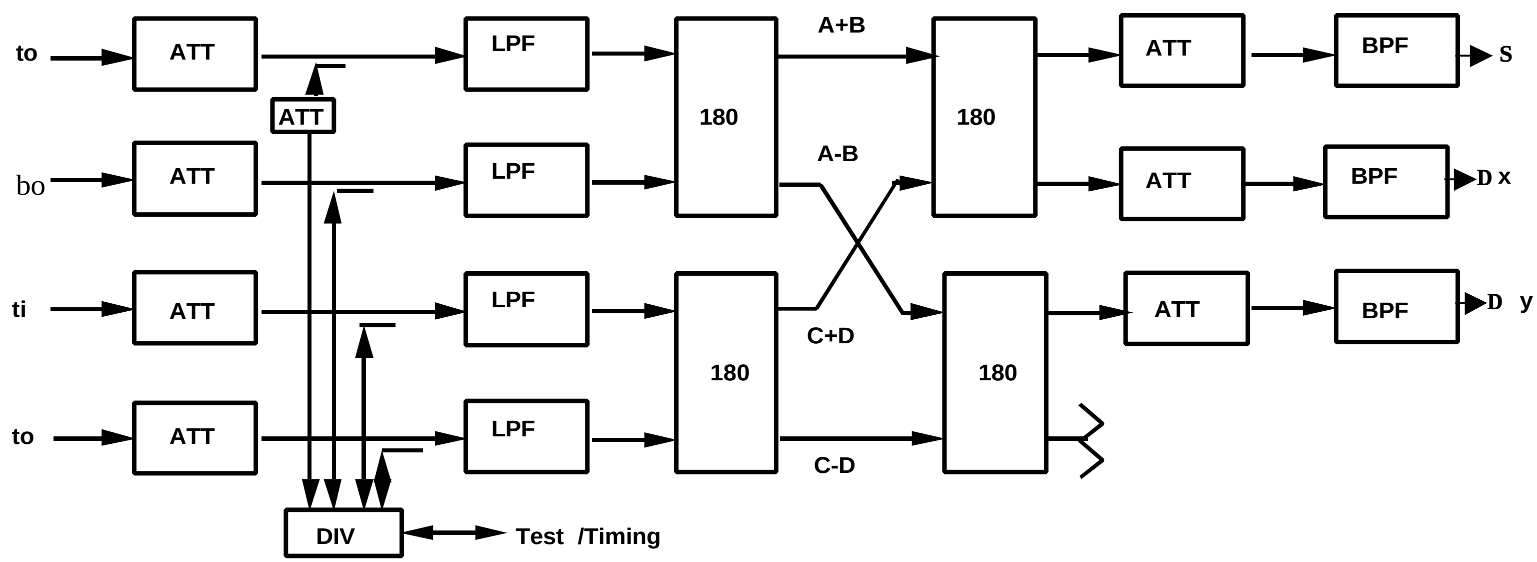
Advanced Photon Source

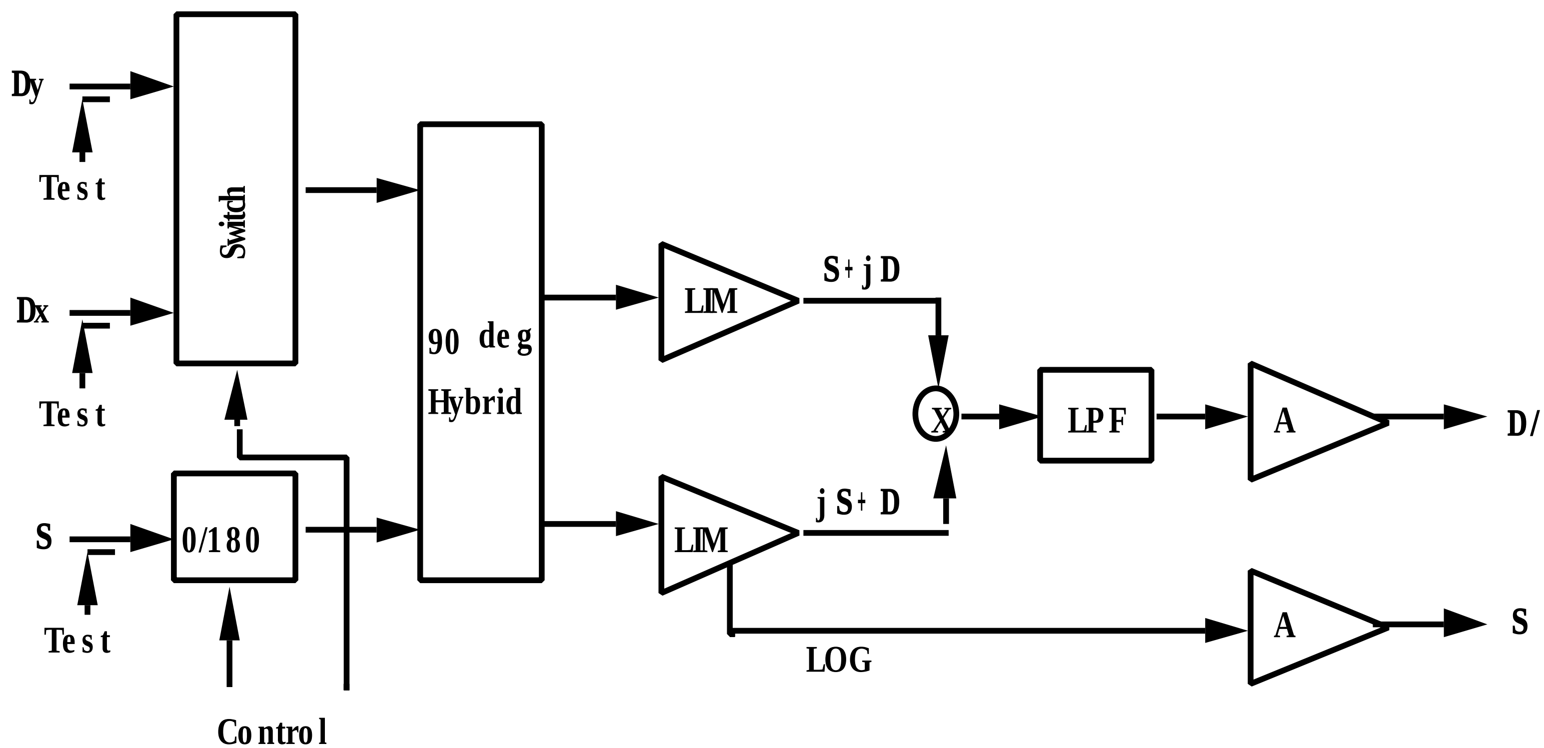
RF Beam Position Monitor Upgrade

Robert M. Lill

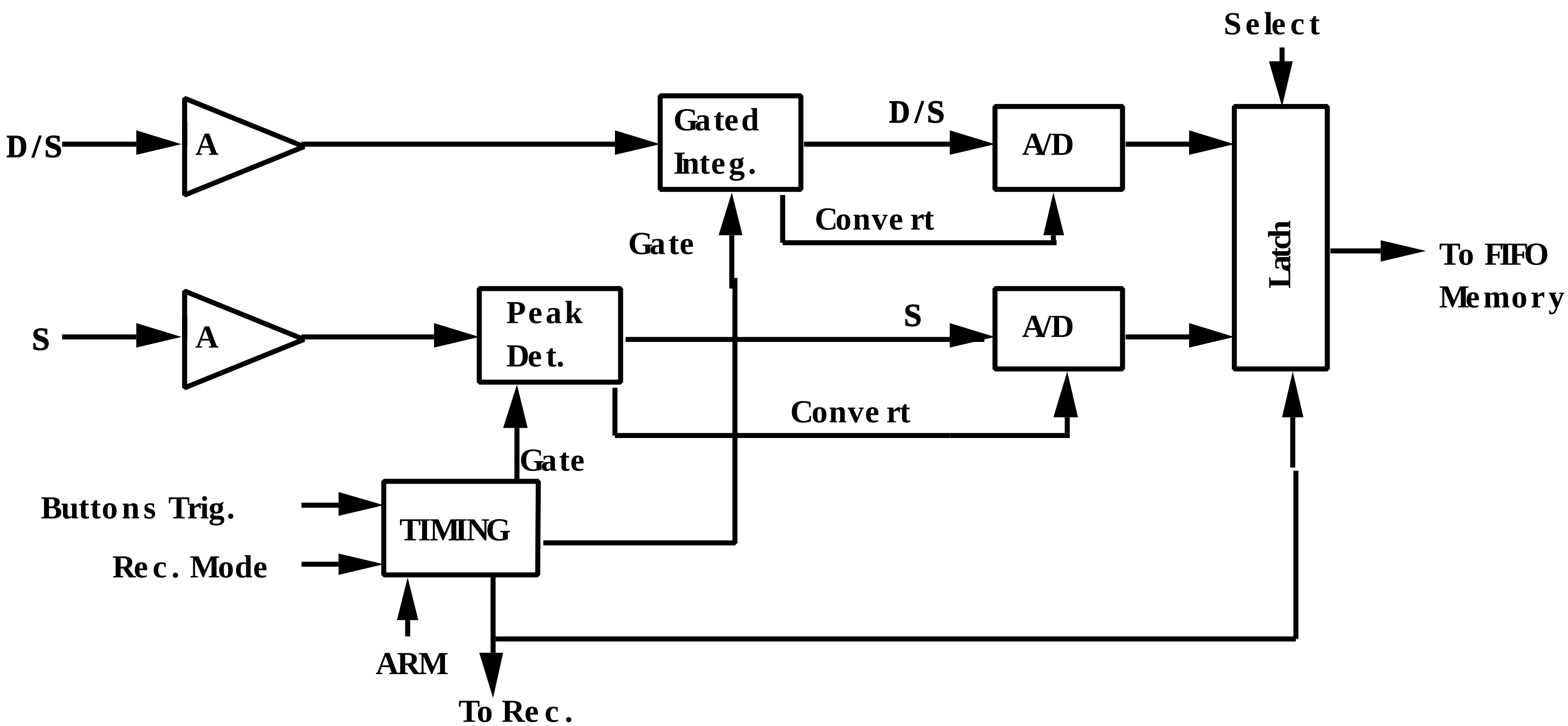
Filter Comparator
(original design)



Monopulse Receiver



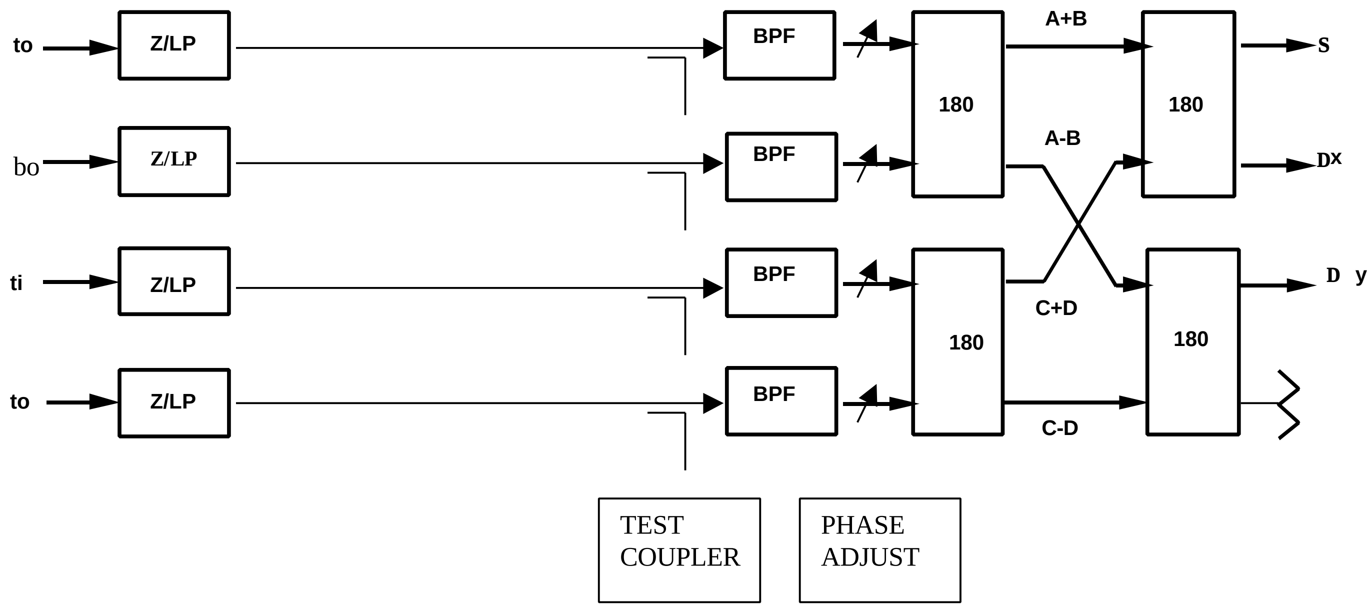
Signal Conditioning and Digitizing Unit



RFBPM Upgrade Design Objectives

- Reduce Insertion Loss of Receiver Front-End
- Reduce Reflected Power Between Receiver and Buttons Electrodes
- Reduce Time domain Band-Pass Filter Side Lobes
- Improve System Maintainability

Filter-Comparator Upgrade



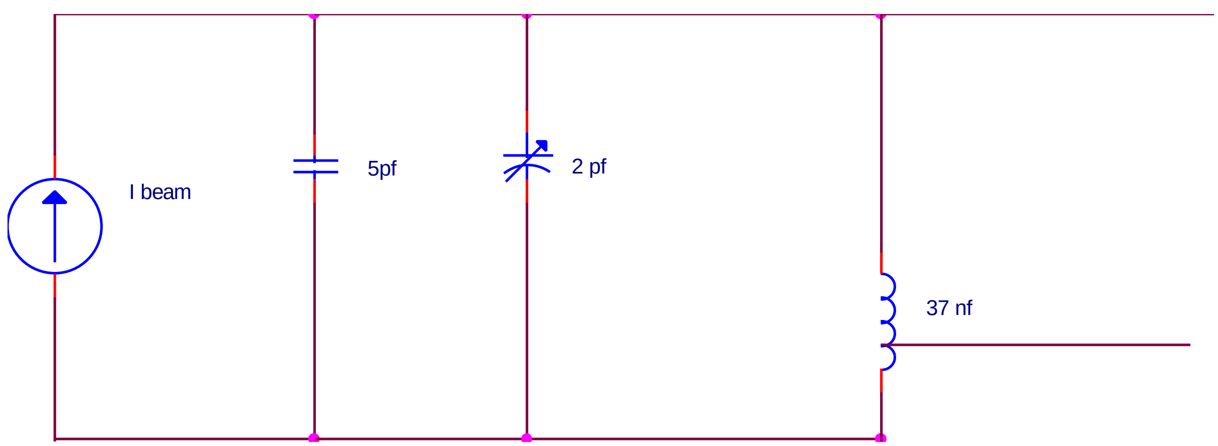
Phase I Matching Network

- Matches the output of the button electrode to 50 ohms and eliminates the need to place 6 dB attenuators on the output of the button electrodes.
- Facilitates moving the band pass filter and comparator out of the tunnel.
- Band limits (100 MHz) the output of the button electrodes.
- Increases button output by 8 dB

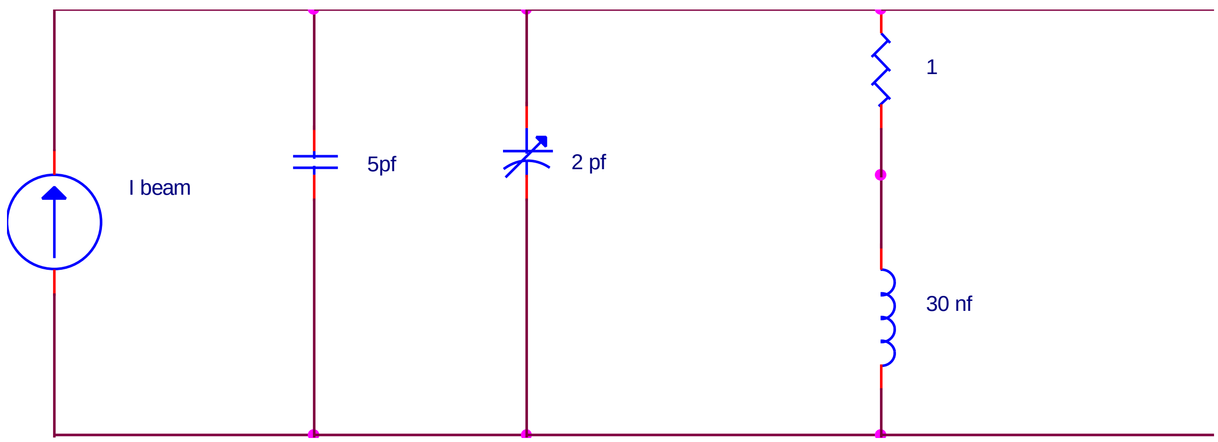
Matching Network Development

- ESRF narrow band (8 MHz 3 dB BW) 16.5 dB signal improvement
- PTI (50 MHz 3 dB BW) with 15 dB signal improvement
- Angle Linear broad band (100 MHz 3 dB BW) with 8 dB improvement includes LPF

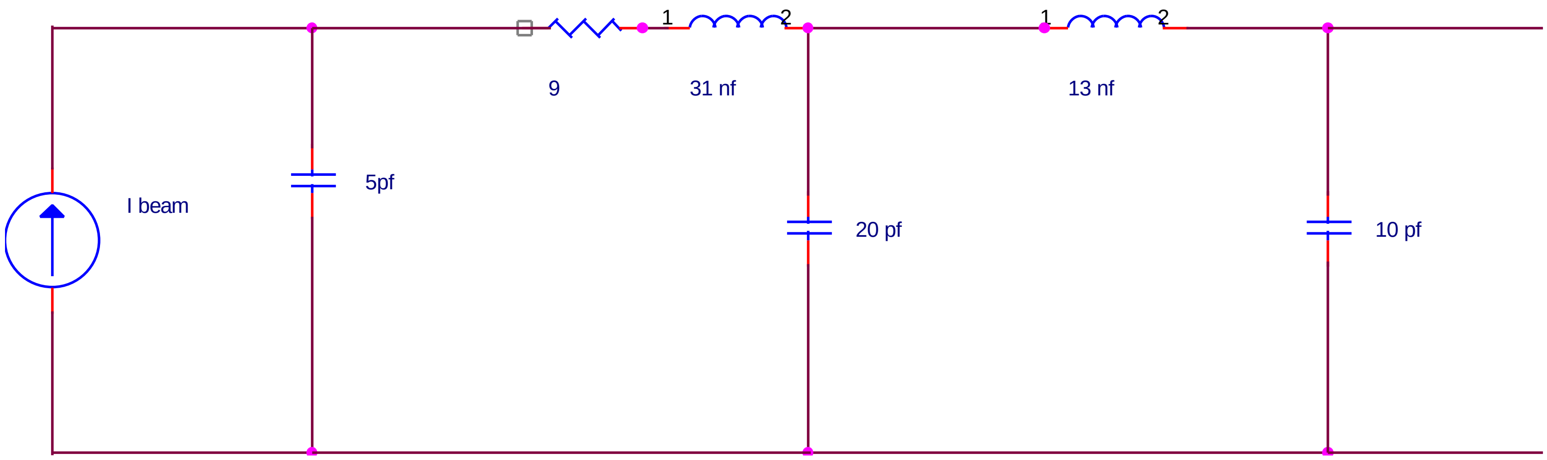
ESRF Matching Network
8 MHz BW



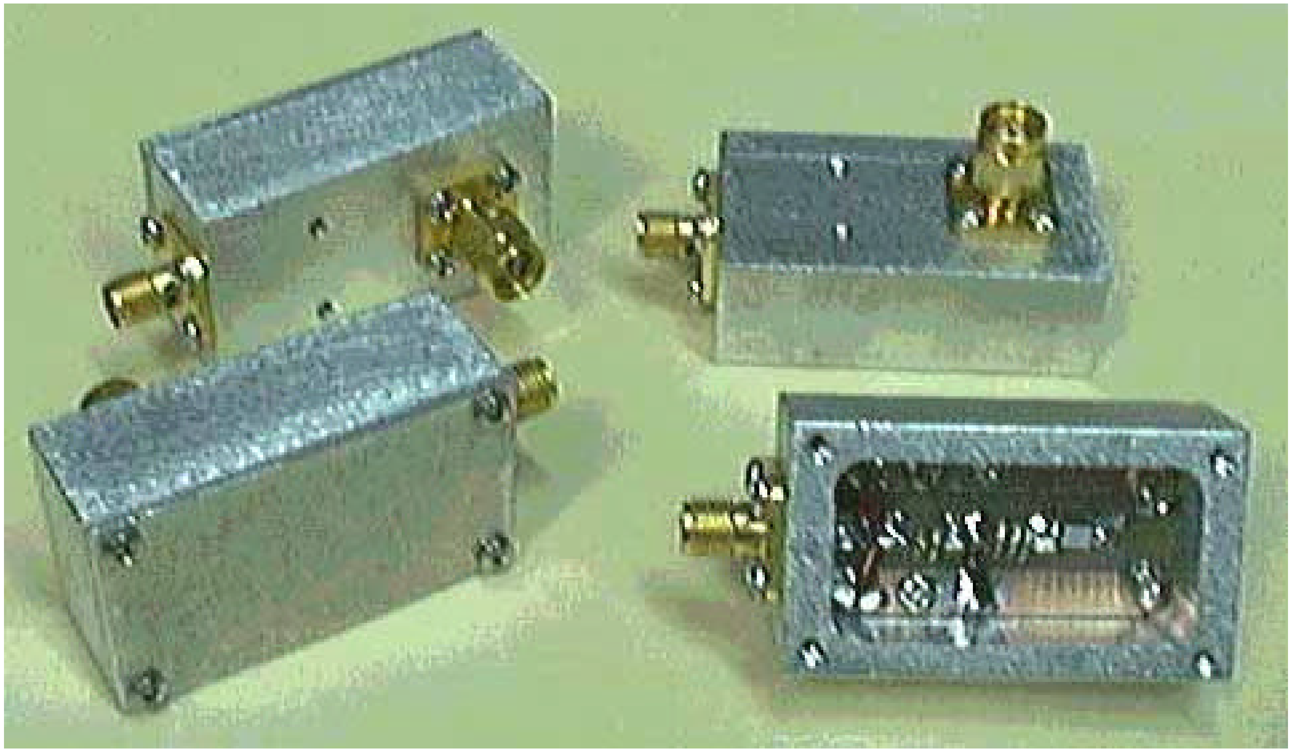
Matching Network
50 MHz BW



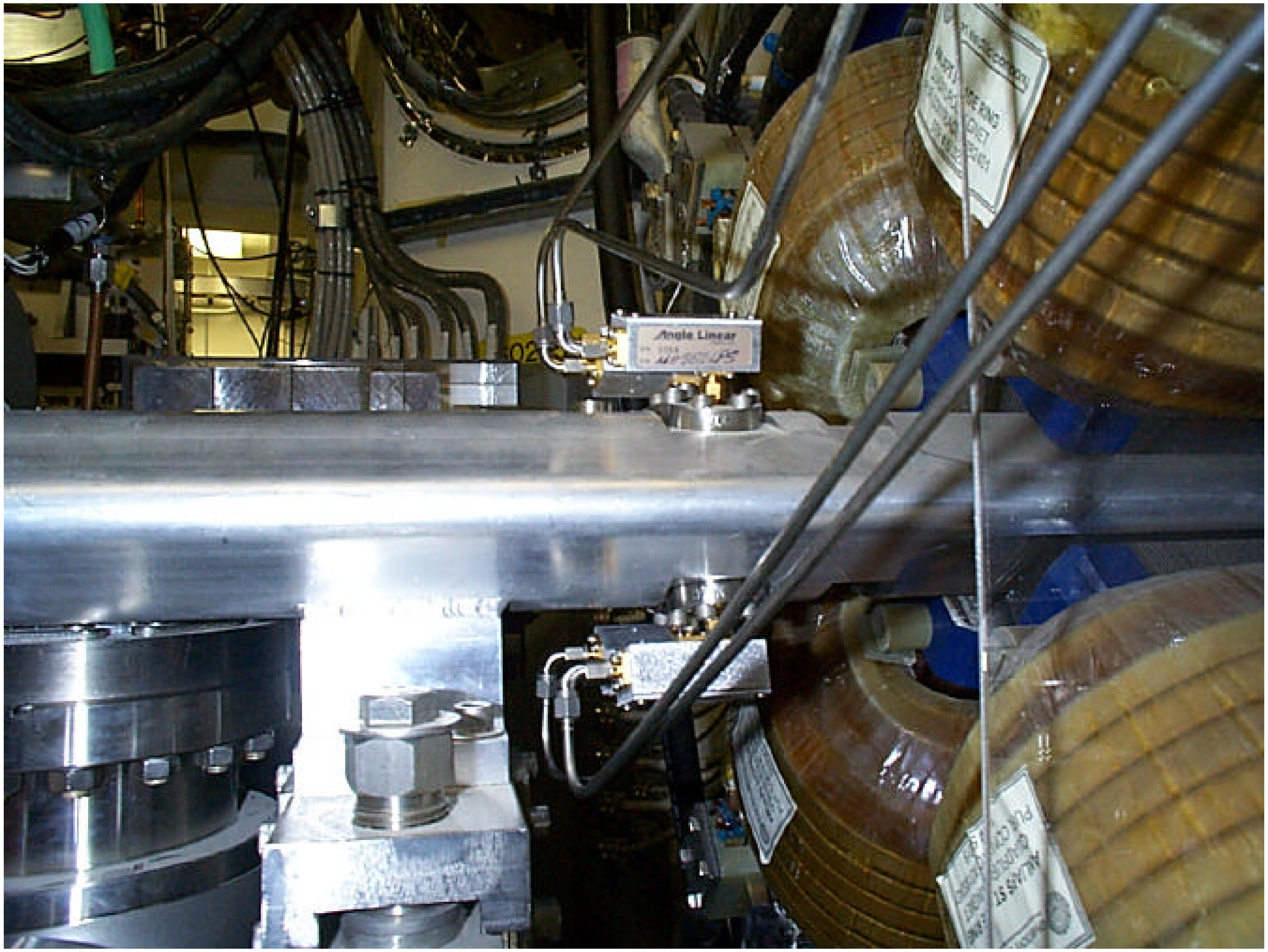
Matching Network
100 MHz BW with lowpass filter



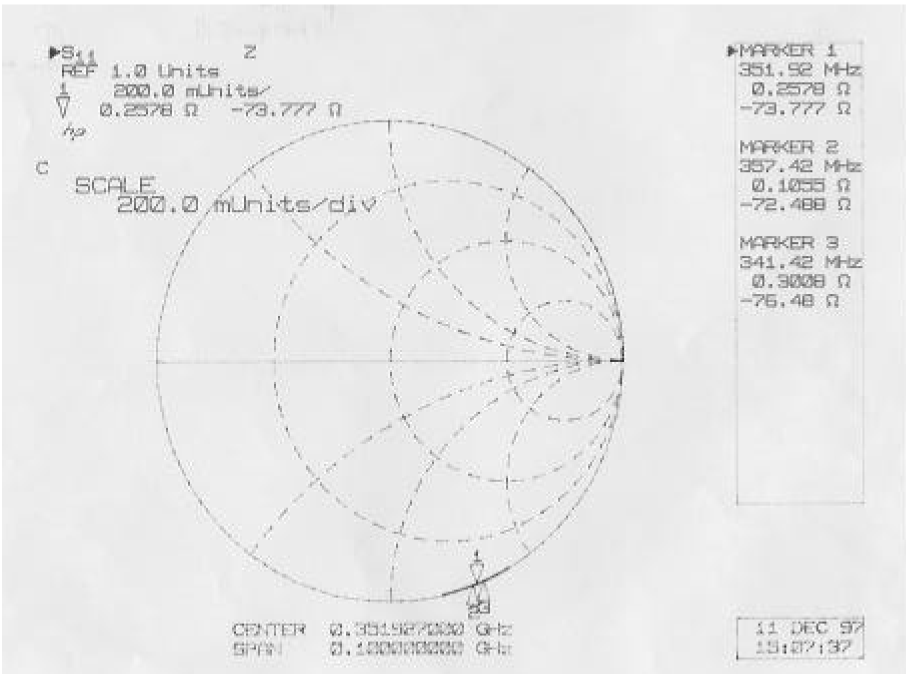
100 MHz BW matching network with lowpass filter as built



Button Electrode Matching Network Implementation

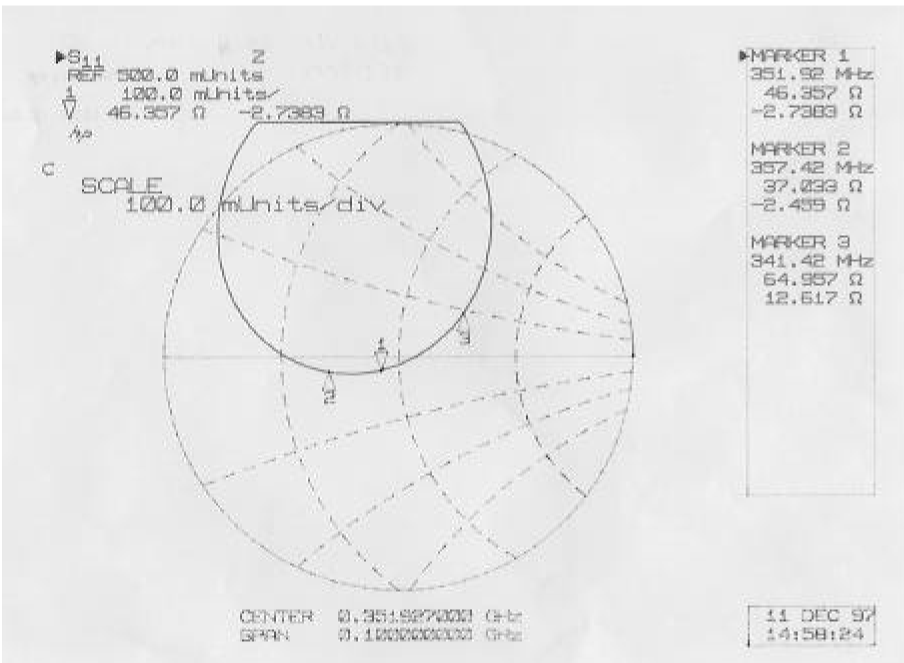


Capacitive Button Electrodes



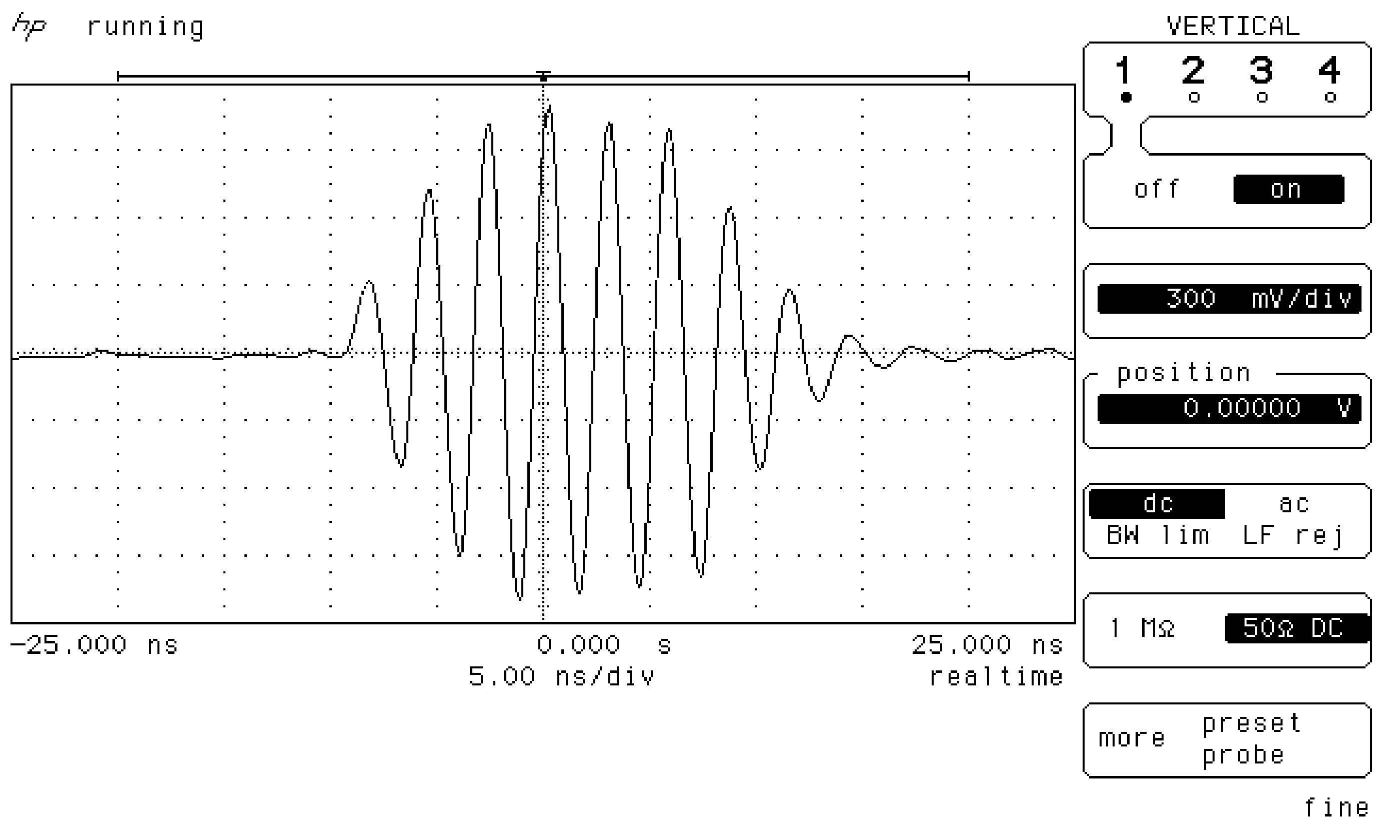
- Button electrode reflects 97 % power on feed through side
- Requires attenuators close to output to minimize reflections

Capacitive Button Electrodes with Matching Network



- Button/matching network measure greater than 30 dB return loss
- 13 dBm (20 mW) button output power in a 100 MHz bandwidth

Matching network output with 6 bunches @ 1.67 ma/bunch



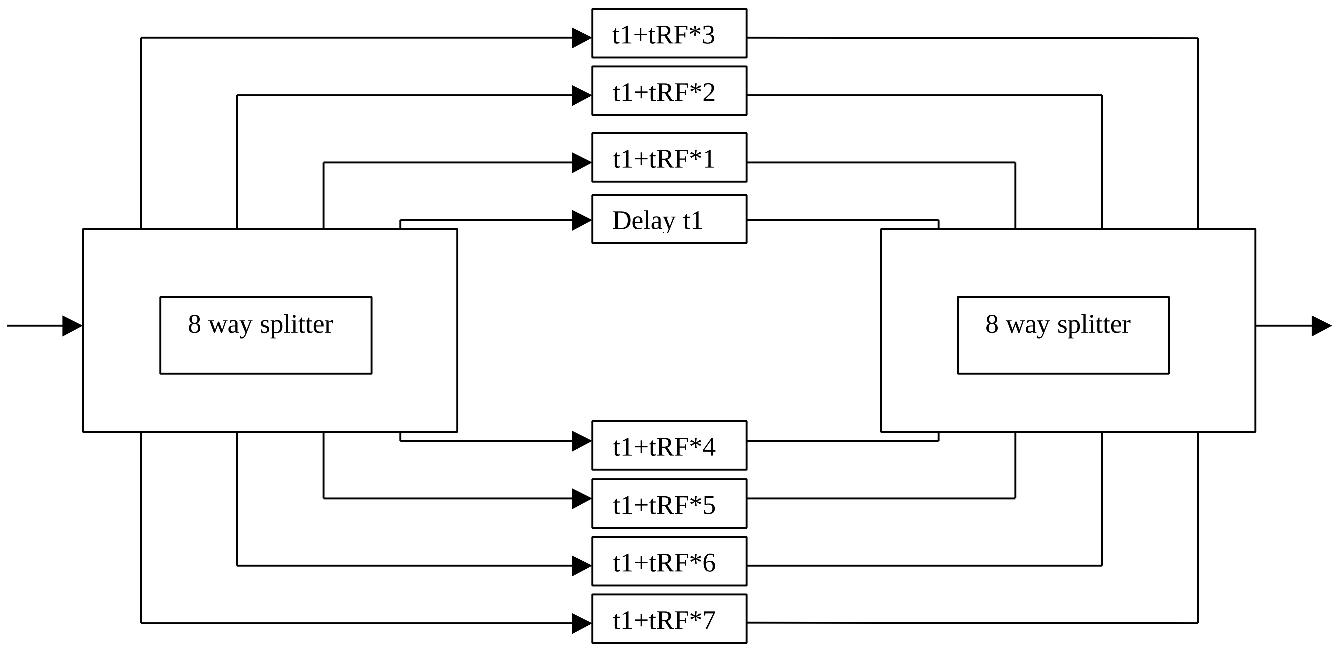
Phase II Upgrade Bandpass Filter and Monopulse Comparator

- Increases signal strength by removing matching attenuators and by using low loss components
- Improves return loss
- Improves bandpass time domain side lobe rejection

Bandpass Filter Development

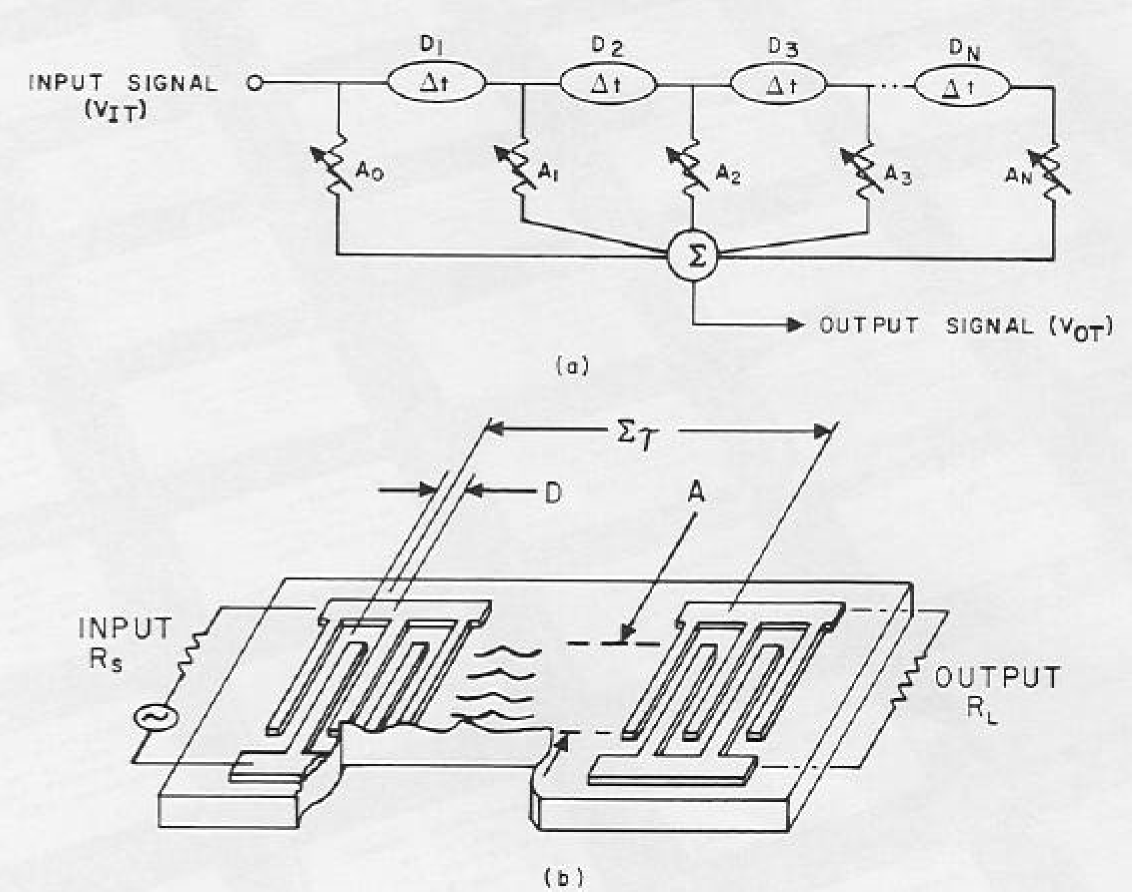
- Coaxial cavity resonator
- Transversal coaxial delay line
- Transversal stripline serpentine design
- Transversal surface acoustic wave (SAW)

Transversal Bandpass Filter

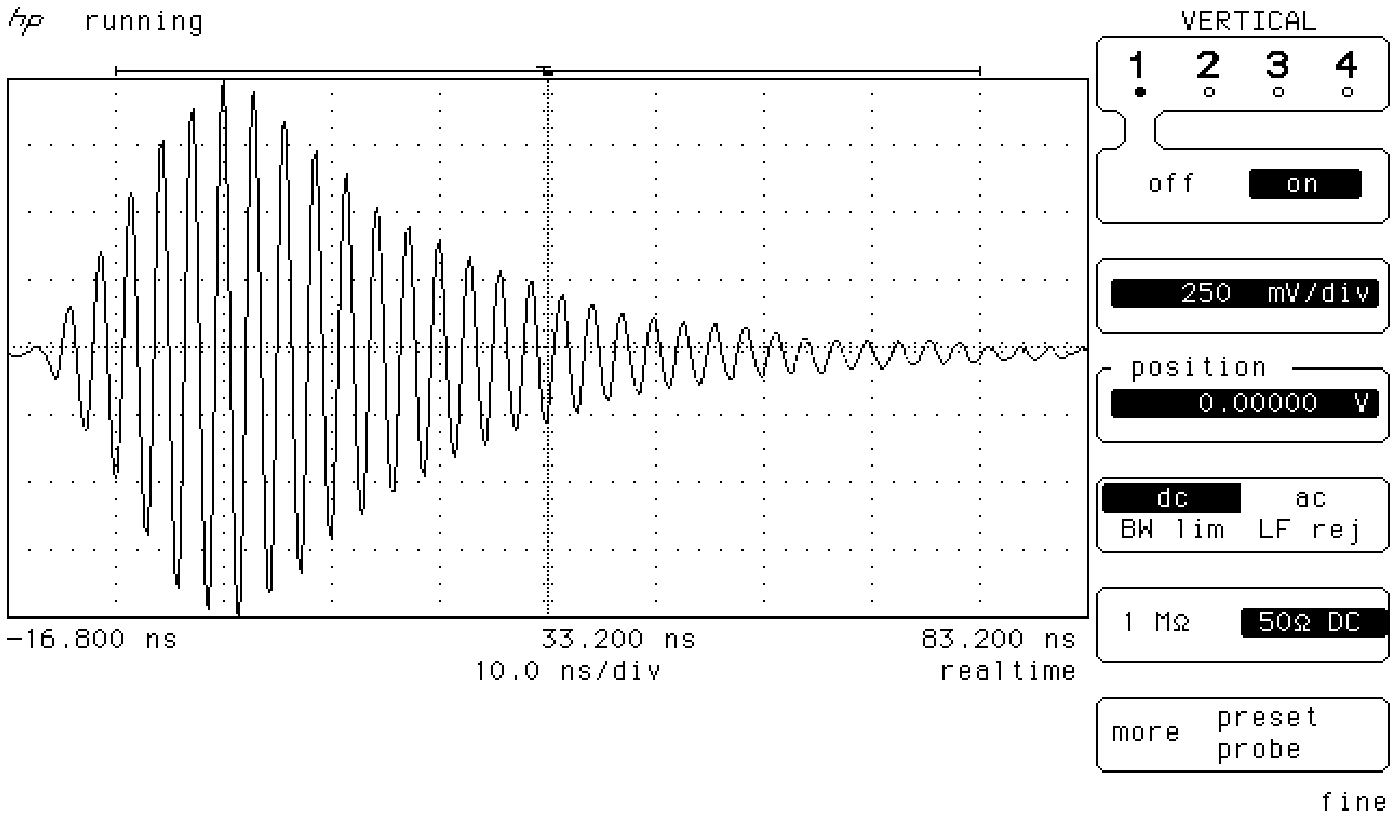


Surface Acoustic Wave (SAW) Bandpass Filter

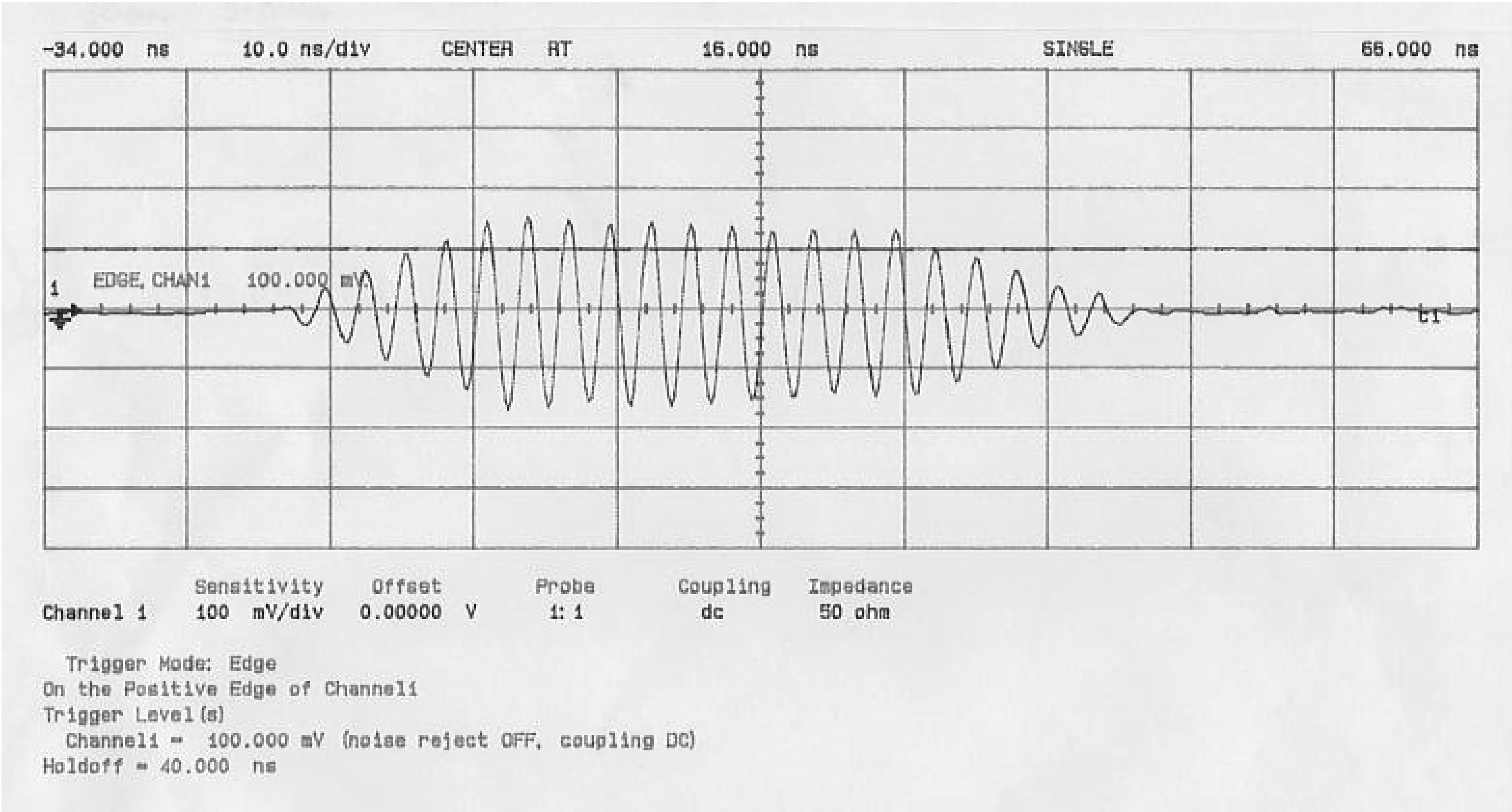
FIGURE 2 – Transversal Filter Schematic and SAW Equivalent.



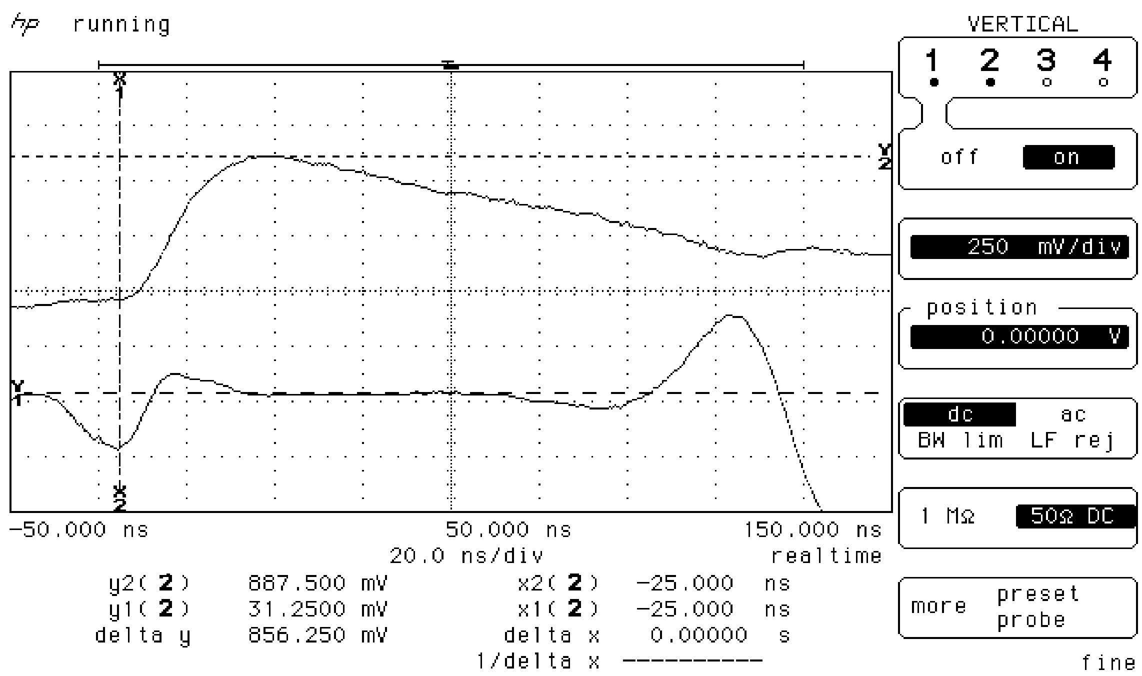
Cavity filters with 6 bunches @ 1.67 ma/bunch sum input



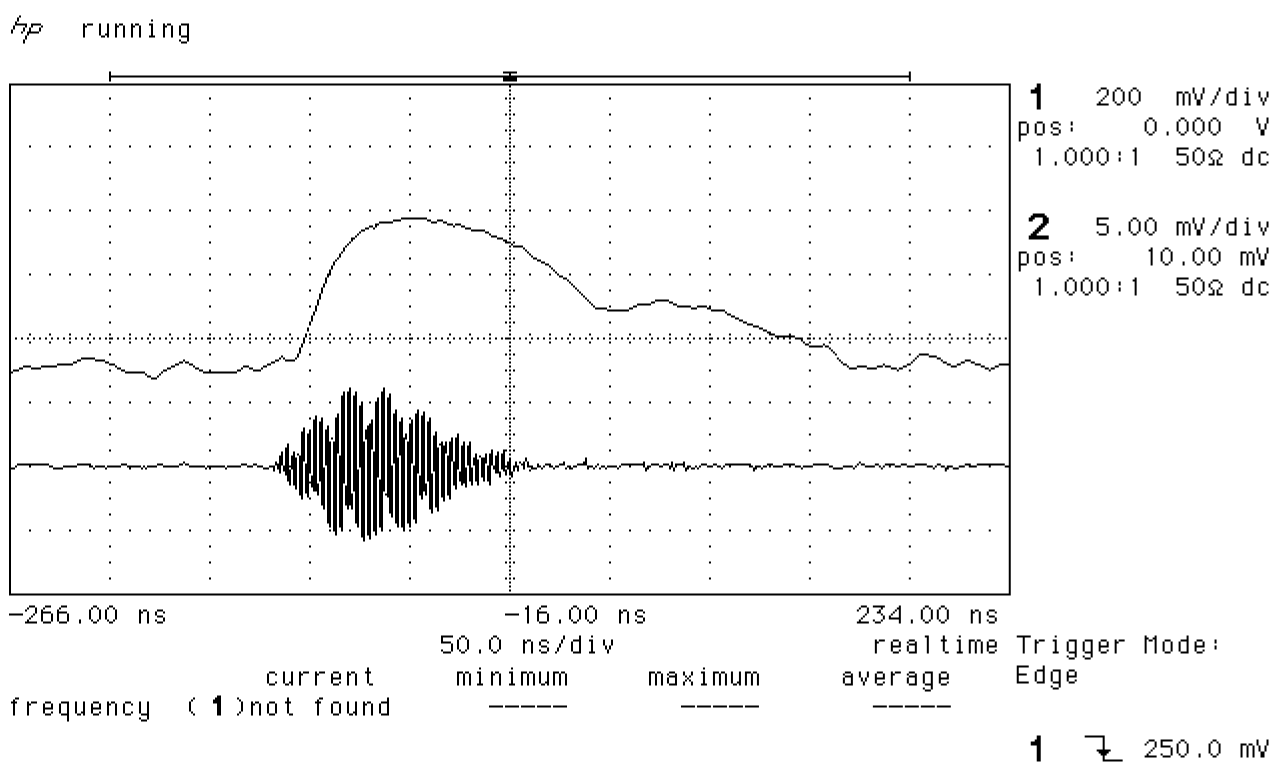
16 pulse transversal filters with 6 bunches



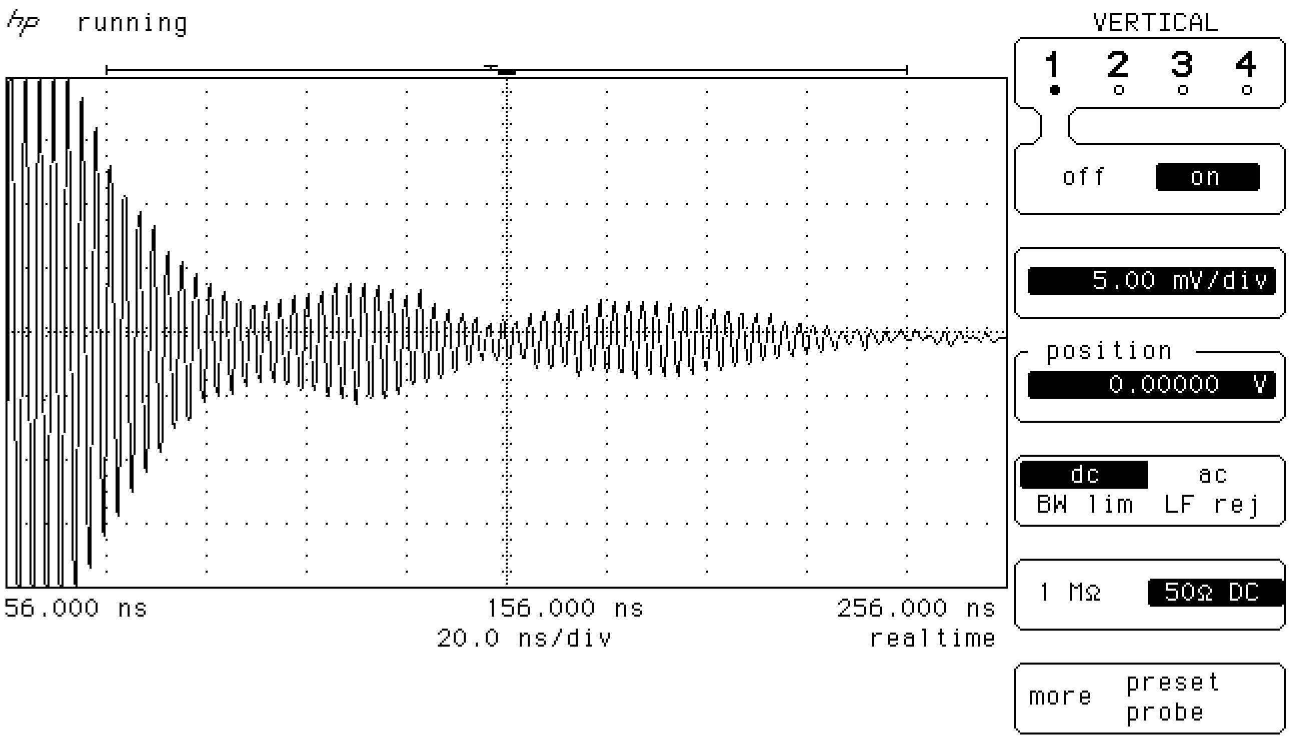
Receiver output with Cavity bandpass with 6 bunches @ 1.67 ma/bunch



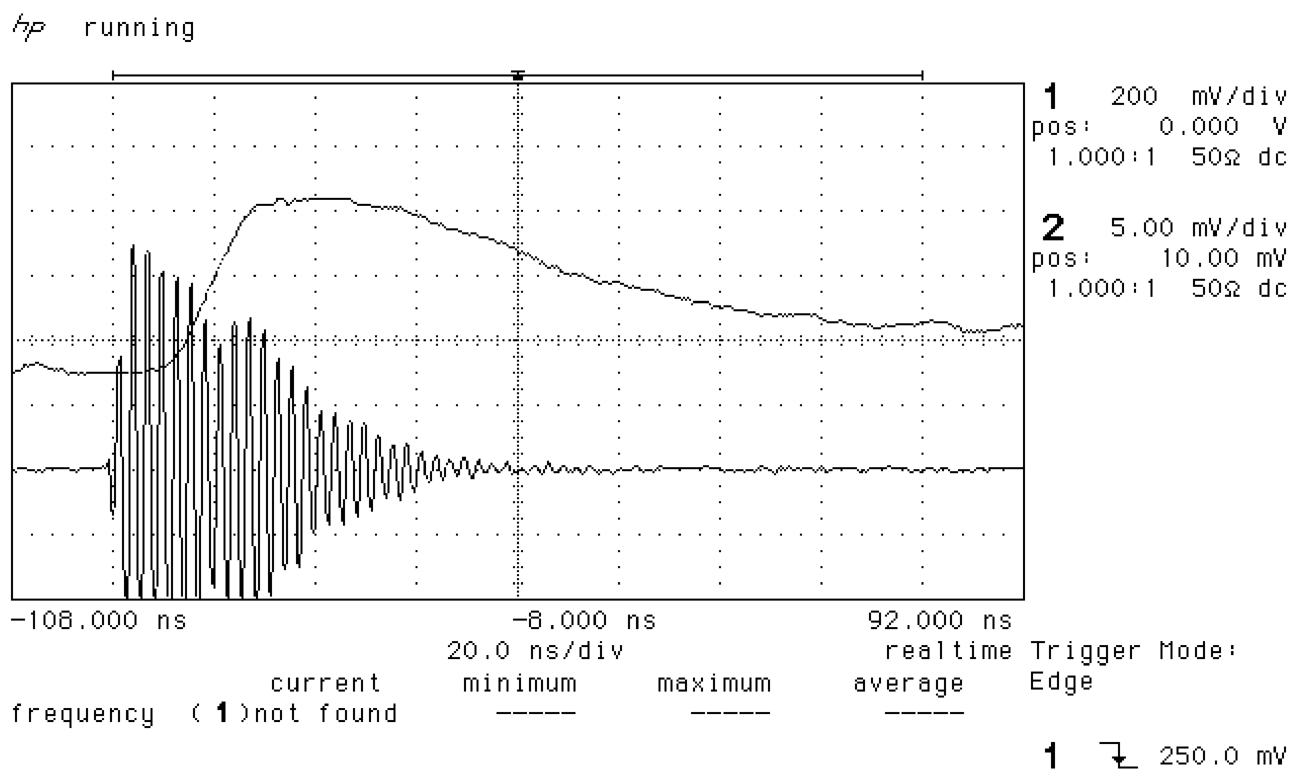
Receiver output with Lorch bandpass filter



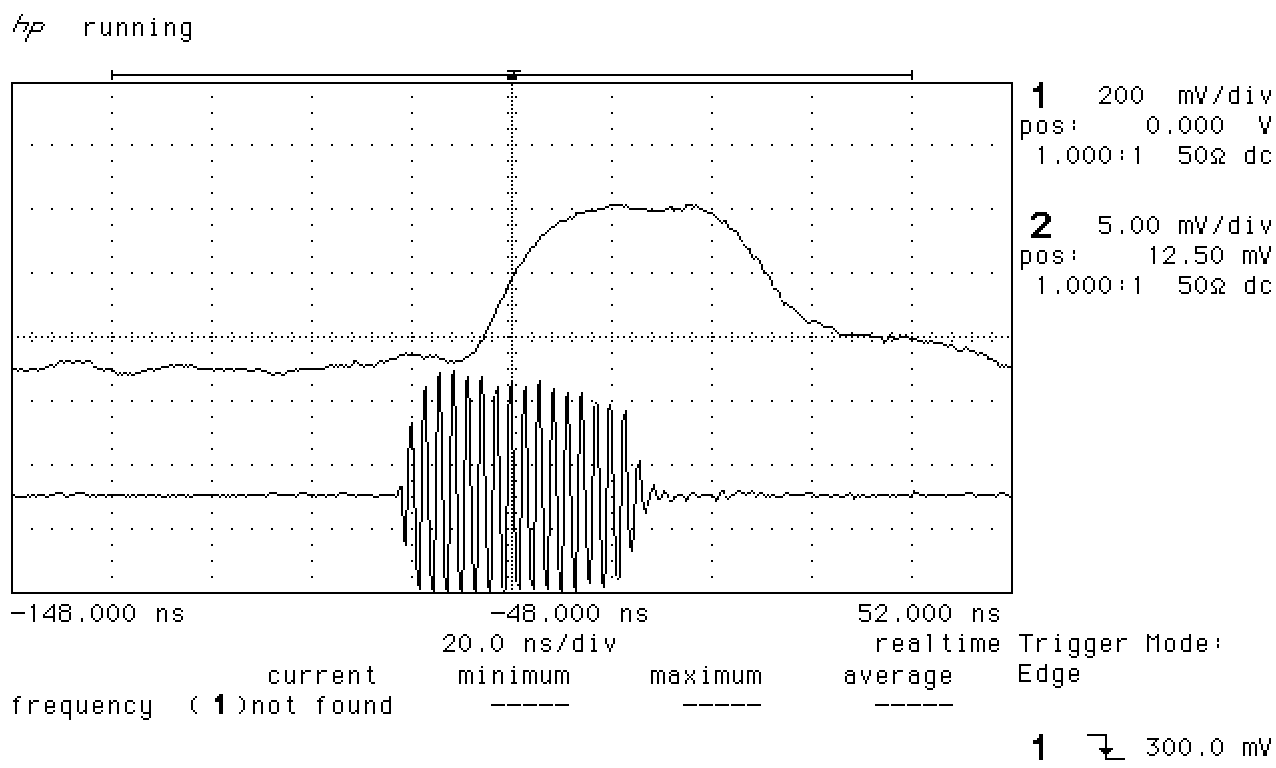
Lorch bandpass filter response



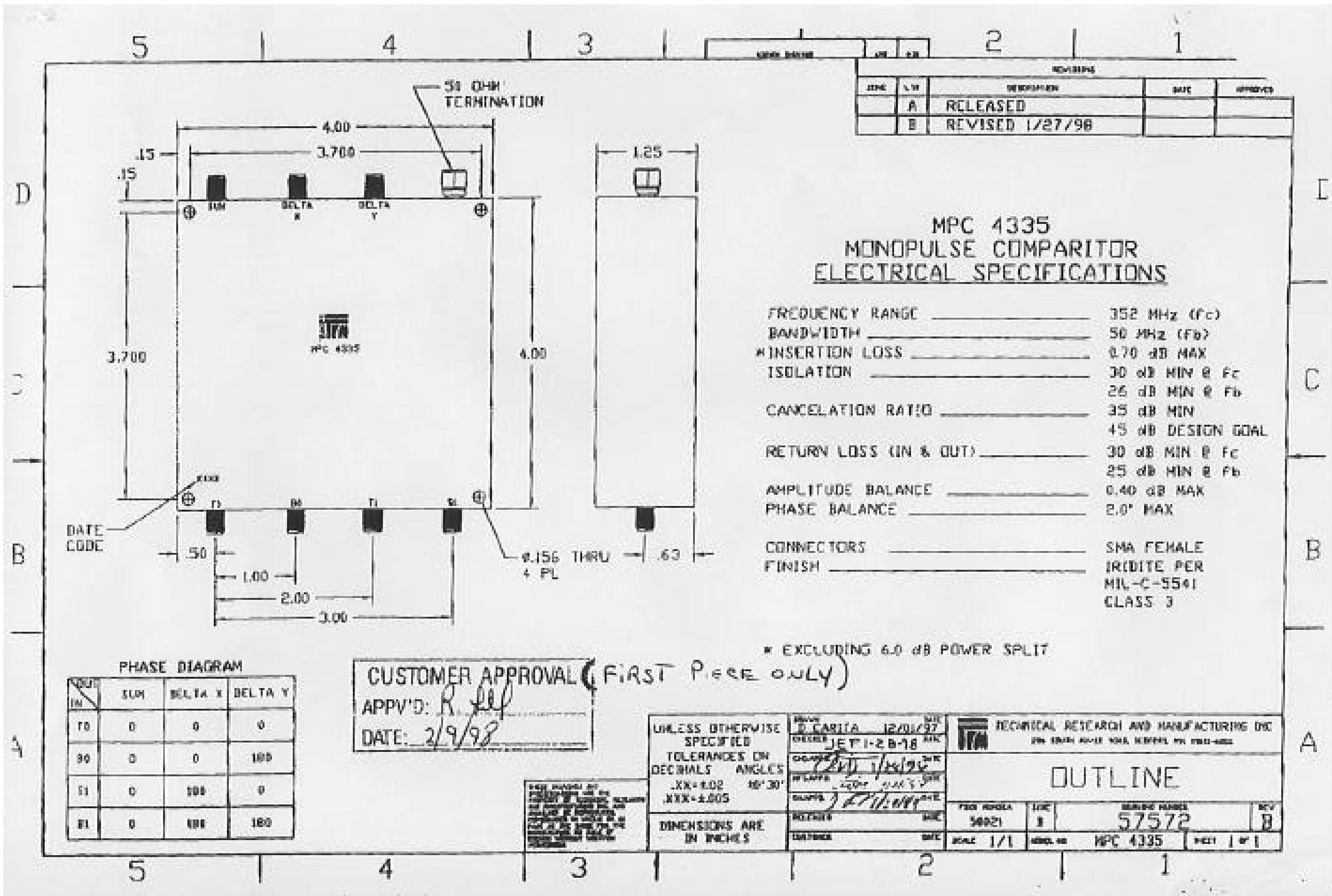
Receiver output with 16 MHz Cavity bandpass filter



Receiver output with16 pulse transversal bandpass filter



Monopulse Comparator Specification



Maintainability

- Test couplers provide access to input signals during operation
- Test couplers provide injection points for self test
- Access to the tunnel to calibrate and repair are minimized
- Future improvements to add sector calibration module can be realized

Major Design Differences

- Matches the button impedance vs. attenuating reflected standing waves
- Moves comparator and band pass filter out of the accelerator tunnel
- Different comparator and band pass filter topologies

R&D PLAN

- Obtain 4 SAW filter prototypes as soon as possible
- Obtain 4 serpentine transversal filter laid out on low cost substrate as soon as possible
- Obtain 9 component rat race hybrid networks (connectorized) by CY98
- Obtain 36 bandpass filters of choice (connectorized) by CY98

Cost

- Phase I cost $150,000
- Phase II comparator estimated cost $250,000